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# SCIENCE

A WEEKLY JOURNAL DEVOTED TO THE ADVANCEMENT OF SCIENCE, PUBLISHING THE  
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FOR THE ADVANCEMENT OF SCIENCE

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## ARE WE AN INVENTIVE PEOPLE IN THE FIELD OF EDUCATION?<sup>1</sup>

EVERY invention, I suppose, is made up of individual and social elements, and combines them in a way different from that of every other invention. There is no more interesting department of literary criticism, or esthetic criticism generally, than that which seeks to trace out the respective contributions of the race and the individual in any work of art. This is illustrated in a recent discussion of the distinction between the folk-epic and the art-epic,<sup>2</sup> the characteristic difference, for example, between the 'Iliad' and 'Paradise Lost.' Some Homer, in the one instance, whatever his name, gave the final form to a poetic tale that must have been shaping itself in the traditions of his people for many generations. In the other instance, in which we may distinguish the poem from the contemporary materials out of which it was constructed, the work of the poet looms large, and the work of the people back of him is obscured by his personal fame. Yet, when we analyze even Milton's art, with all of its manifestation of a fearless and independent personality, we find it related in the subtlest ways with the literary tradition of his time.

So it is in the history of mechanical invention. We have seen recently a running discussion of the origin of the electric trol-

<sup>1</sup> An address before the chapter of Phi Beta Kappa, at Vassar College, June 10, 1907.

<sup>2</sup> By Professor C. B. Bradley, *The University of California Chronicle*, June, 1906.

ley car. This very modern invention is commonly referred for its beginnings to the electric railway first operated at Richmond, Virginia, in 1888. But it appears that that undertaking had a forerunner, and that forerunner in its turn had a prototype, and the successful American inventor is found to be only the topmost figure of a human pyramid, made up of no one knows how many experimenters in this particular field. The Patent Office has difficulty enough in distinguishing each new invention from its patented predecessors. But when we go aside from the series of formal patents and look to the succession and mingling of motives and ideas, the tangle passes our ability to unravel. We can only see how inextricably the stroke of individual initiative is enmeshed in the movements of a whole people, and that very complication we find it a delight to contemplate.

Now, this social character of all invention appears in a peculiarly vital way in any original work in education. For education in a special sense not only springs from the people, but in turn creates the people from which it springs. Education is its own father. An over-emphasis on individuality in education would quickly carry us away from the line of direct succession. It would give us isolation and sterility instead of recreating the spiritual life of the race.

One can not add too quickly that in the nature of things the danger of a dead lack of individuality is usually a more threatening danger. But let us at once get down to our examples. To begin with, we may take the kindergarten. There has hardly been a more distinct and conspicuous invention in the whole history of schools. It is a thoroughly conscious and modern work of art, in which the personal agency of the inventor comes to the fore. That is the

very weakness of the invention. To this day it has not been assimilated. In our educational concert it is a voice that sweetly sings in tune but that refuses to blend with other voices of the chorus. There may be different explanations of this lack of accord. It may be that the individual note is permanently at variance with anything that can be made universal. Or it may be that the kindergarten is merely in advance of the age and will bring the rest of education round into adjustment with itself. It seems pretty clear that both explanations are in part correct. The kindergarten, with certain other forces that have worked toward similar ends, has brought our elementary education a long way toward its type of faith and practise. Yet the emphasis on what is distinctively Froebelian still keeps it a thing apart, and seems likely to set a permanent limit to its ascendancy.

It will appear from this reference to the work of Froebel that we are not now concerned simply or chiefly with those inventions which bear the sharp stamp of one man's individuality. It is a minor consideration that the invention should be known at all as the work of a single inventor. Some of the most marked of immediate successes and ultimate failures have had that distinctive imprint. Such, for example, was the monitorial system, in the forms given to it by Joseph Lancaster and Doctor Bell. Such a system may have a large usefulness of its own in the course of educational progress, but it is as scaffolding rather than as part of the permanent structure. Its very insistence upon that which is one man's makes it less fit to serve the great needs of Everyman.

So in varying degrees the educational inventions of the ages combine the distinct contribution of this or that inventor with the broad tendencies of an inventive

people. What are some of the other inventions which Europe has contributed to educational history? I mention only a few of them and with little thought for sequence of any sort. There is the educational system of the Jesuits, particularly in its seventeenth and eighteenth century form. There is the English university, made up of federated colleges. There is the seminar, which has been such an instrument in the making of German university instruction. There are two recent contributions of the Swedish people, the Sloyd system of hand-work and the Ling system of educational gymnastics. Let us add the seminary for teachers, the school garden, the Hilfsschule or school for backward children, the system of higher institutions for commercial education, the Gouin method and various other successful methods in the teaching of modern languages, the English system of university extension. And doubtless many others will occur to you. When we come to think over the list, it appears that much has been accomplished; and that European education has not only been greatly widened since the Middle Ages, to reach a manifold larger constituency, but has also been improved to a wonderful degree by the progress of educational invention.

When we would institute a comparison between European and American contributions to such improvement, it is well that we consider first the wider range of invention. The world at large gives to the Americans the credit of being a highly inventive people as regards mechanical devices. The attention of our people was early turned in this direction. Certain conspicuous successes fired the national imagination, and the stress of economic need drove us to the same end. The Patent Office became a center of national pride. To take out a patent or buy the right to sell a patented article or at least

to buy something with the magic patent label attached thereto, became a well-nigh universal ambition. And in sober truth our record in the making of useful inventions is really wonderful. At first thought and without an effort you can recall the lightning rod, the steamboat, the cotton gin, the whole series of reaping machines down to the latest combination harvester, the sewing machine, the telegraph, the telephone, the arc and the incandescent electric light, the phonograph, and twenty other things that are now counted among the necessities of modern life. It is a dazzling list, and may well make us forget the things we have not ourselves invented, but have borrowed from other lands. On second thought, however, we recall those notable creations, the steam engine, the balloon, the power loom, the locomotive engine, the daguerreotype—first-fruit of modern photography—the spectroscope, wireless telegraphy, and many others that the wit of Europe has devised. However much we may lead in the number and variety of our cunning contrivances, there is enough for which we are indebted to other lands to check our conceit and assure us that we have competitors.

On the whole, however, in the domain of mechanism we are undoubtedly in the lead. The fact that the number of patents issued annually in the United States is now only a little less than the whole number issued in all of the rest of the civilized world is not without significance. But when we turn to creative literature and the other arts the case is changed. Here, on the whole, the leadership rests with Europe. We have done good work in this field and are rapidly doing better, but not yet with that confident leadership which we display in mechanical invention. Many of the best short stories are ours. We have a score and more of writers of creditable verse—and even Europe does not seem

to be over-productive of great poems in these days. We are producing some virile sculpture that is not merely imitative, and our painters can now command the respect and admiration of the world. The superiority of our illustration-art is recognized. We are erecting many good buildings and are producing some good music. But after all, the preponderance of inventive excellence in these departments is still conceded to Europe. Our architects study at the Beaux Arts, our musicians at Leipsic and Berlin, and our young painters are known to the world when they have exhibited at the Paris Salon.

How, then, does it stand with us in the field of education? I think any one who reads in the German pedagogical literature of our day has now and then a sense of hopelessness of any educational originality. The range of its suggestion is in fact astounding. The new plan and conception of educational procedure which is just dawning above his horizon is very likely to appear in some German pamphlet or even in some 'Handbuch der Pädagogik' as a familiar notion, the boundaries of which have been well marked out and its values weighed in the balance. So any one familiar with the stream of educational influence which has long been crossing the Atlantic in our direction will proceed with caution in naming our American contributions to educational invention. Yet it will be admitted that pedagogic discussion in Germany and in other countries of Europe often outruns by far the practical embodiment of such ideas in working institutions, and even the great reach of German educational doctrine still leaves some things to the educational makers of other lands.

The Europeans themselves are generous in giving us credit for the origination of a variety of educational contrivance. Among the particulars in this bill of credit

have been mentioned the American school of library practise, the kitchen garden, the high school laboratory for instruction in natural science, coeducation in secondary schools and colleges, the combination school of the Pratt and the Drexel Institute type. It is difficult for us to form a list of our own. We are too close to the facts to be sensible of their distinguishing characters, and besides we know that Europe has many surprises that might trip us if we claimed too much. But at a venture I would suggest the following as among our original contributions to education, making no claim, however, that the list is all-inclusive or even includes all of the best that we have done.

First, the non-sectarian elementary school for all classes of the community, answering to our democratic social organization and our religious liberty.

Secondly, the American high school, serving at once as a continuation of the elementary school and an introduction to the higher education, with courses meeting a variety of tastes and needs.

Thirdly, the American university, with its combination of instruction and research, of cultural and technological courses, and with liberal and professional departments often dovetailing into each other. To this might be added that notable invention, that new development of personal efficiency, the American university president.

To these institutions, at the core and center of our educational system, we might easily add a number of minor features of that system, no one of them insignificant in itself. The summer school may be mentioned, with its home-study development, as in the Chautauqua type; the text-book in its better forms, and the better type of instruction based on the use of the book; the college gymnasium, for physical education; the consolidated country school, with provision for the transportation of pupils;

the organization of public libraries and museums in close connection with the work of public schools. How many others there are that come crowding on the attention! One is tempted to mention Helen Keller as one of our most admirable educational achievements. The story of her training into normal and honored womanhood is one of the most stimulating passages in our educational history. And Tuskegee is another. Then, too, we recall our schools for the training of nurses, which in a very few years have come to enroll twenty thousand students annually. I may speak of another example, which falls within my own sphere of labor, for as a new invention it was the work of my honored predecessors. I refer to that special type of industrial training which is connected with the introduction of domestic reindeer into Alaska.

In that northern country the necessity of making some better provision by which the natives might clothe and feed themselves, was the mother of this combined industrial and educational invention. Reindeer were imported from Siberia. Teachers were brought from Lapland. And the Eskimo were set to the lesson of caring for the deer, of breaking them to the sled, of using them in profitable service of the incoming white population; and so of adjusting their lives to a new industry, by which they might maintain themselves in the face of new conditions which threatened their very existence. Here was a truly constructive treatment of a most difficult racial problem. A new industry was fitted to new conditions and a new education was based on that new industry. While the arrangement has not yet shown what its full development may be, it has become well established in these more than fifteen years, and already it has made its place and proved its usefulness.

But we can not fairly estimate the

measure of our inventiveness unless we turn to the other side, and see what are some of the defects in our system which we have left uncorrected. These are the points where our educational invention has thus far failed to do its work, and they are neither few nor unimportant. I think it will appear that all along the line, from the bottom to the top, our educational system, the object of so great national pride, is still marked by serious inadequacies.

We have not yet made any great improvement in the nurture of children at home, up to the kindergarten age or the age of the primary school.

We have not yet brought the kindergarten into full adjustment to our educational system nor devised any adequate substitute for the kindergarten.

We have found ways of keeping one half of our pupils in school up to the sixth or seventh grade but we have not found ways of keeping all of them to the end of the elementary course.

We have not yet organized nature studies in the schools into any well-knit adjustment to general education.

We have not yet carried our instruction in drawing up into fully effective training for the fine arts, in secondary and higher schools.

We have not yet brought our religious education, as carried on in Sunday-schools, into any effective parallelism with the secular instruction of the public schools.

We have not yet brought our normal schools into satisfactory adjustment with our cherished sequence of schools from the kindergarten to the university.

We have not yet wrought out a satisfactory arrangement for the training of teachers for secondary and higher schools.

We have hardly as yet established a permanent teaching profession.

We have not devised adequate means of

giving needed cultivation, esthetic, intellectual and moral, to the individuals who make up the student body of our mammoth universities.

We have yet to work our way through the gaseous, centrifugal atomism of our college elective courses into an organized and unified national culture.

We have not yet achieved a national standard in our academic and professional education, nor have we organized any effective and economical cooperation among our schools of graduate instruction and research.

We have not yet devised ways by which public education can be definitely and adequately focused upon the improvement of our national morality.

The list, again, is by no means complete, but it is surely long enough for the purposes of this discussion.

I do not take a pessimistic view of the situation in which these defects appear. In every one of the particulars enumerated, serious efforts toward improvement are making even now, and we can not doubt that full success will ultimately be achieved. There have been devoted teachers who have labored long for such improvement, and in some instances their accomplishments have been great and beneficent. But that our triumphs in these particulars have been local and exceptional, rather than permanent and national, will be generally agreed, and it is well that we look this unwelcome fact in the face.

We may now attempt a direct answer to the question which was asked at the beginning. Are we an inventive people in the field of education? We are unmistakably, an inventive people in this field. It can hardly be doubted by any one who looks upon the exuberant Americanism of our elementary schools, the great expansion and continued readjustment of our second-

ary education, the growth of our universities and of university influence in ways that catch so exactly our national characteristics and turn them to academic ends; nor can it be doubted by any one who watches from year to year the spread of our education into new fields by new and untried processes. We are inventive in our education, but it is not yet clear that we are preeminent in this regard, and our educational invention still lags far behind our invention in the domain of mechanism.

We may be easily misled by the flattering reports of foreign visitors. With all of their frankness in pointing out our defects their general criticism of our schools is for the most part extremely favorable. But we must not forget that education with us is in the sweep of a strong tide of popular sentiment. Every invention that we have put forth is carried forward by that current and finds opportunity to do, in full swing, its destined work. Not that individual inventors do their work unhampered and with no discouraging delays. That could never be. But by contrast with Europe, the way of educational improvement here is direct and clear. We cannot yet fairly judge what our education would accomplish under greater difficulties and in the face of closer competition. It is safest for us to take the moderate view, and hold that our educational successes thus far, great and glorious as they are, are only great enough to confirm our hope and confidence, and not yet sufficiently great to insure to us the ultimate leadership.

Our inventiveness in this field is less conspicuous, as has been said, our education shows less of readiness to seize obscure suggestions and carry them through to unlooked-for triumphs of efficiency, than that which we have long disclosed in our Patent Office reports. Yet this field is at least as interesting as the other. It makes intense appeal to widely differing minds, and

public attention is often drawn to new educational projects in a measure that is truly astonishing. What is needed is that that public interest should be more sustained and more clearly manifest; that the inventor in education should have the unfailing stimulus which has goaded our mechanical inventors to their most strenuous endeavors. And on the part of the inventor himself there is need of all the patience and resource of the designer of new mechanism; and of other qualities, subtler far than these, which it may be worth our while to consider at this point.

The inventor in education does not bring before the people a new object which they are to look upon and admire and use. The people are the very stuff of his invention, public sentiment is his atmosphere, he is an artificer of human society. Accordingly he must have, many times over, the patience of the mechanical inventor. He must be willing to merge his fame in the larger life of the invention. For if it is a real and living invention he will find that there are many collaborators, and it may take generations to bring the design to its perfection. In education it is generally true that an invention that is only of one man size is not large enough to last. Yet the work calls for zest and courage, and there is ground for individual encouragement. Social changes are accelerated in these days. The single generation has, more than ever, its chance of striking an arc of appreciable advancement; and there was never a time when one man in his one earthly life had a better chance of doing some work of noble note. I believe the spirit of educational invention can be quickened among the men of America, to meet the larger demands that are upon us. And if this language seems to spread out shield and spear in the household of Lycomedes, it is not that I am seeking Achilles at Vassar. It should be said

rather that the highly educated women of America are themselves to have a most important part in this educational quickening. Indeed, it is not too much to hope that the time is at hand when our men and women will take share and share alike in this work—alike but different. And we may trust and pray that the great work that our women are already doing in every phase of social improvement may not cause the men of America to dream that their responsibility can be shifted, but may rather remind them that they must not fail in their part.

It may be well to enter here upon some brief discussion of three or four of the problems now calling for constructive leadership. In the first place, let us make note of an unfinished movement, which demands our best skill and will surely reward its exercise. It has been said that the education of the school and education by apprenticeship, after centuries in which they have gone apart, are drawing near together in these days. It seems fair to expect, in fact, that the school of the future will be the result of their union. The combination appears in many forms. Most familiar of these, up to the present time, is the school laboratory in the natural sciences. Here instruction from the book assumes a subordinate place and the pupil learns by what he does. Already, too, the method of the scientific laboratory is permeating other departments of the school. It has influenced the teaching of history and the languages, and we may even see its influence extending to the teaching of law in the professional school. But now the school and the apprentice system are drawing together in other ways. The movement is obvious in manual training and domestic education. The actual contact of the two systems in their organized forms, however, has been especially marked in the past two

years. At the Carnegie Technical Schools in Pittsburg arrangements have been entered into by which boys will take a part of their training for certain trades in the ordinary course of apprenticeship, under the control of the trades unions, and another part of their training for the same trades in the technical schools. At the University of Cincinnati the experiment is making of combining work for wages in a regular shop with the studies of an engineering course, two young men counting for one in the shop by alternating on one-week shifts, each taking his university studies in the week that he is not at the bench. The experiment is watched with the liveliest interest by both shopmen and university men and thus far it gives promise of success. In the movement toward the establishment of public trade schools, now under way in Massachusetts and Connecticut and in several other states, the relation of the apprenticeship to the school is a question of the utmost importance, both educationally and in its connection with the problems of trades unionism. From a general pedagogical standpoint the combination of the methods of the literary school with the methods of apprenticeship seems one of the most promising of present opportunities for the exercise of educational invention.

May I venture, in the second place, to speak of the present problem in the higher education of women. I will not say what I think about the subject here and now, when I am so happily indebted to your generous hospitality. I do not think you would care to have me indulge in the language of compliment. But before I came to Vassar, let us say, the question of woman's higher education in America seemed to me to lie about as follows: That, after the great advance we have made in this field, which has commanded the atten-

tion of the world and the admiration of a good part of the world, we have come to something like a standstill, and some of the most important steps have not been taken as yet. It has taken a great struggle to establish fully the higher education of woman as a simple human need. But that battle has been won. The integration of woman's education with the general scheme of education has been brought about. But the differentiation of woman's education is yet to be accomplished. Let us admit that the task of integration was by far the greater task. But does it follow that the differentiation is no task at all? Or to put it in other words: the functions of men and women in society are different in many ways. Do those differences lie wholly beyond the range of education? I am confident that they can not permanently be left outside of the range of education; but the task of bringing them under educational treatment is one of the greatest difficulty. It calls for the highest exercise of inventive skill and patience. In coeducational institutions, under a system of free election, the problem tends to solve itself by the gravitation of women toward certain courses and of men toward certain other courses, while still other courses are common ground. But this solution is only partial and unsatisfactory. Some practicable scheme of preparation for mother-work will, we can not doubt, be devised in the course of time. There will be, some day, an education for home making and for woman's leading part in the finer forms of social intercourse, which will do on the higher academic plane what was done in a more petty way, generations ago, in popular finishing schools for girls. But this, too, is only a part. There is to be, further, a serious preparation for woman's part in the economic, the industrial, and even the political world. What the all-round solution of this problem will

be, I can not tell nor even guess. But if it meets the need, it will be an educational invention of the highest order of excellence.

In the third place there is the international organization of education. Commissioner Draper has recently called attention to the tremendous number of men and women engaged in teaching throughout the world to-day. There are not far from three and one half million of them, according to his estimates. And for the most part they are engaged in what is essentially the same work, wherever they may be. The full realization of the unity of this great body of teachers, when it is attained, must have profound consequences for the peace and civilization of the world. Already we are working toward such unity in a number of definite and special ways. Many of these ways are already familiar to all: The visits of teachers and other educational leaders of one country among the schools of other peoples; systematic efforts of one people to spread a knowledge of their culture and ideals among other peoples, as exemplified in the *Alliance Française*; the exchange of university professors; and a variety of other procedure. If the diplomatic relations of nations have passed into an economic stage, it should be added that they are passing into an educational stage. Mr. Barrett, the chief of the Bureau of American Republics, urges, with good show of reason, that if we wish better commercial relations with the proud and sensitive peoples of South America, we must first meet them on higher ground, through an understanding and recognition of their culture and education. Already we can see signs of the emergence of world-standards in school education and university education and particularly in professional education. It is an immediate and practical need that we put our higher education into shape to deserve, and by deserving to compel,

recognition, the world over, of our academic and professional degrees. All of these things call for new procedure, new devices, and new coordination of existing agencies. That is, in the language of this discussion, they call for a new exercise of educational invention in its very widest range.

Finally, the international need emphasizes the national need. Such a thing has happened repeatedly in the history of international relations. What we must do to take and keep our place, among the nations of the earth, reveals to us what we must do at home. No one in his senses, I am sure, would propose a centralization of American educational systems. But we need as never before an effective cooperation of our state educational organizations, and of our institutions of learning under more private forms of control. And when education is spoken of here, the meaning is education in its widest reach, from the elementary schools through the colleges and universities, from the most general to the most special of its developments, through the several forms of professional instruction, through organized scientific research, through our provision for libraries and museums and those movements which promise for us the making of a really national art. The organization of what may be called our national education in a manner suited to the spirit of our institutions and in forms commensurate with our standing among the nations—this is an undertaking which must tax the imagination and make demand for administrative originality such as the academic world has seldom seen. But it is a work that is to be done. And it will undoubtedly be the work of many men and women, brought together in intense cooperation, and be extended far beyond the limits of a single generation. It will be a work of national invention.

Such, as it now appears, is some small part of the work of education that lies immediately before us. It is a work that may well call for the most serious consideration of this greatly influential society, which aims to make its philosophy a guide into the larger life. The plea which has been offered amounts in sum to this: That by all means you will give encouragement and stimulus to our already awakened spirit of educational invention; for it takes no second sight to perceive that the times call for the exercise of that spirit in the highest things to which it may aspire.

ELMER ELLSWORTH BROWN  
U. S. BUREAU OF EDUCATION

#### SCIENTIFIC BOOKS

*Electrochemistry.* By Dr. HEINRICH DANNEEL; translated by Dr. EDMUND S. MERRIAM. Part one. New York: John Wiley & Sons.

This is the first of a series of three volumes which Dr. Danneel proposes to write upon the subject of "Electrochemistry." In this volume the modern theories of electrochemistry, as well as their physicochemical foundations, are discussed. The second volume will contain experimental results and methods of measurement, while the third will be devoted to the technical applications of the subject.

Theoretical electrochemistry is beyond the stage at which any radical innovation in the method of treatment is possible. The author does, however, depart from the more usual procedure in discussing transport numbers after conductivity; and wisely too, we believe. We are not, however, convinced of the advantage of introducing a preliminary chapter on the history of electrochemistry in which much of the subject matter to follow is assumed to be known.

This volume, like its companion volumes in the Sammlung Göschen, contains a surprising amount of fact and information within a very small compass. Whether such condensation is always desirable in a theoretical subject, where abridgment of statement does not

necessarily mean a lessening of mental effort, may be questioned. I am reminded of the Abbé Terrassou's remark about a book "that it would be shorter if it were not so short." We are convinced, however, that this very brevity coupled with its clarity will assure it a place of its own among text-books of electrochemistry. We imagine, for instance, that it would be an excellent book to furnish a mature student with a brief, though comprehensive view of the whole subject.

The translation is vigorous and clear. We were sorry to see the familiar expression "migration of the ions" supplanted by the less apt "wandering of the ions."

The physical appearance of the book is better than that of the German original.

ARTHUR B. LAMB

*Researches in Experimental Phonetics; the Study of Speech Curves.* By E. W. SCRIPTURE. Washington, D. C., published by the Carnegie Institution of Washington, November, 1906. Pp. 204.

Under this title is published the groundwork of the results of Dr. Scripture's recent work abroad, in the laboratories organized at Munich, Berlin and Zurich. Save for illustrative examples from the records, the present volume deals almost exclusively with methods; nearly all of the last fifty pages are taken up with tables, some of which appear for the first time, and should prove most helpful to other investigators along these lines. A discussion of the precise philological and psychological bearings of the results we may await in another volume.

The speech curves studied are obtained from amplified tracings on smoked paper of phonograph (cylinder) and gramophone (disc) records. Dr. Scripture has here employed mainly the disc records, the horizontal movement of the recording point giving a more accurate tracing. The workable portion of the records is practically confined to the vowels. The voiceless sounds as a rule give nothing beyond a straight line. The investigator seems to have brought his method to a high degree of technical perfection. The drawings illustrating the apparatus are unusually clear.